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⑤⁴ Isolation on/off valve.

⑤⁷ Fluid-flow control apparatus is disclosed by which magnetically-positionable elements (39,25) within a rigid body (9) can be externally manipulated using a controlling source (39) of magnetic flux. The relative attractive forces which bias internal magnetic elements into normally-closed sealing engagement are substantially altered by repositioning the magnetic elements in response to the controlling magnet flux. Complete sealing or isolation against back flow through the valve under conditions of net positive outlet pressure is inhibited by the internal double-acting sealing elements (23,24) which respond in unified manner to the controlling magnetic flux. Sealing surfaces (54,56) on the elements are dome-shaped to limit the effect of horizontal forces imposed thereon. The elements are biased into floating relation and reduced in dimension to inhibit contact with internal sidewalls of the valve body.

EP 0 273 614 A1

ISOLATION ON/OFF VALVE

The present invention relates to a valve for controlling the flow of fluid therethrough.

Fluid under pressure is commonly controlled by means of a valve which includes a valve seat and a mating element that can be controllably positioned relative to the valve seat. The position of the mating element relative to the valve seat within the valve is typically controlled from outside the valve with the aid of sliding or rotating seals surrounding some portion of the movable element that protrudes through the valve.

Valves for controlling toxic fluids under pressure are known to obviate sliding or rotating seals by relying upon magnetic fields externally applied to control the operation of internal valve parts. Magnetically-actuated valves of various types are described in the following United States Patent Specifications - 3,783,887; 4,331,171; 4,382,449; 4,114,852; 1,132,570; 3,877,478; 3,774,878; 3,212,751; 4,506,701; 4,350,182; 4,349,042; and 4,018,419.

Such valves are also known comprising a valve body having first and second channels contiguous with respective ports, of which one is a fluid inlet and the other is a fluid outlet, a valve member disposed in said first channel and having a seal face co-operable with an aperture, between the first and second channels for providing selective communication between said first and second channels, a first magnet disposed in a chamber defined in said valve member and dimensioned relative to said chamber such that it can move therein between first and second positions corresponding to open and closed positions of said valve member, a second magnet disposed in said second channel for magnetically urging said first magnet to one of said first and second positions and magnet means disposed remotely from said first and second channels for urging said first magnet to the other of said first and second positions.

In accordance with one aspect of the present invention there is provided a valve in which said seal face has an outwardly extending domed surface adapted for closing engagement with said aperture.

In accordance with another aspect of the present invention there is provided a valve characterized by means for biasing said valve member into floating relation in said first channel for limiting the contact with the surfaces thereof.

Single-acting and double-acting valve elements may be magnetically controlled from a location that is external to the valve body to provide fluid flow control and fluid system isolation without the potential hazard of sliding or rotating seals between the

fluid system and the environment. The valving apparatus according to the present invention thus permits convenient control of fluids under pressure simply by manipulating the strength and orientation of an external magnetic field applied to internal magnetically-responsive valve elements. Single-acting valve operation according to the present invention may serve as a pressure-enhanced, normally-closed valve that can be magnetically activated to pass fluid in the downstream direction from the fluid supply. Also a double-acting valve according to the present invention may serve as a pressure-enhanced isolation valve which prevents fluid flow in both directions, for example, under conditions of excess back pressure, until magnetically activated by an external, controlling magnetic field.

The invention is described further hereinafter, by the way of example only, with reference to the accompanying drawing which illustrates a cross-sectional view of one embodiment of a valve in accordance with the present invention.

A generally cylindrical valve in metal body 9 includes integral fluid ports 11 and 13. Alternatively, the fluid ports 11 and 13 may be welded to body 9 using electron-beam welding techniques, or the like, to eliminate threads, flanges and other discontinuities and the associated probabilities for leaks. Each of the fluid ports 11 and 13 is coupled to an internal channel 15, 17, respectively, which are coupled to each other through an aperture 19. Fluid flow through the valve is controlled by the spacing or engagement between the sealing surface 21, 22 surrounding aperture 19 and elastomeric valve seals 23, 24 carried on a movable element 25 and a sealing element 34. The element 25 is generally cylindrical and is mounted for sliding movement within the fluid channel 15 in a direction that carries the valve seal 23 into or away from sealing engagement with a sealing surface 21 of the aperture 19. The element 25 includes a sealed internal, elongated cylindrical chamber 27 which contains a generally cylindrically-shaped magnet 29 that is free to slide from one end to the other within chamber 27.

A magnet 32 for attracting the magnet 29 carried in element 25 into sealing engagement is itself encapsulated in the movable sealing element 34 which includes the elastomeric seal 24. Thus, with the magnets 29 and 32 disposed in attractive orientation and carried by their respective sealing elements 25 and 34, the aperture 19 is sealed from both sides by the seal 23 engaging the surrounding upper surface 21 and by the seal 24 engaging the surrounding lower surface 22. These magnetically-

enhanced seals are further enhanced by net fluid pressure in channel 15 (which enhances the seal between surfaces 21 and 23) or by net fluid pressure in channel 17 (which enhances the seal between surfaces 22 and 24), thereby assuring complete isolation between the fluid ports and channels that couple to the aperture 19. Another magnet 38 (shown smaller to depict a source of relatively lower-level magnetic flux) is encapsulated within an end cap 36 in magnetically attractive orientation to magnet 32 and the end cap 36 is beam welded to body 9, as discussed previously, to eliminate the formation of joints and the possibility of leakage occurring. The magnet 38 of lower-level flux is thus incapable of overcoming the attractive force between magnets 29 and 32 that bias the seals closed.

The magnetic attraction between magnets 29 and 39 (when magnet 39 is repositioned, upon actuation of button 41, into close proximity with the end plate 35), repositions the magnet 29 to the upper position within chamber 27 and carries the element 25 and the seal 23 away from engagement with the sealing surface 21. This repositioning of the magnet 29 away from the magnet 32 substantially reduces the attractive force therebetween, and magnet 32 is attracted with greater net force toward magnet 28. Sealing element 34, which carries the magnet 32 and seal 24, is thus slidably repositioned away from sealing engagement between seal 24 and surface 22 to a position of close proximity to the magnet 38.

The valve continues to operate in the open mode, under the control of the magnetic flux produced by the magnet 39. Once the magnet 30 is repositioned remotely from the end plate 35 (or the magnetic flux of an equivalent electromagnet is decreased), the net attractive force between the magnets 29 and 32 is again restored, the magnet 29 is repositioned within the chamber 27 closely adjacent the aperture, and the respective elements 25, 34 and seals 23, 24 are repositioned against both sealing surfaces 21, 22 surrounding the aperture 19. The magnetic force of attraction between the magnets 38 and 32 is reduced and is overcome by the attractive force between magnets 29 and 32 to restore the valve to its normally-closed setting. Thus, fluid flow through this embodiment of the valve of the present invention is further controlled by repositioning movable magnets orientated so as to be mutually attractive, and carried by movable sealing elements disposed on each side of the aperture away from their respective positions of sealing engagement with the surrounding surfaces of the aperture, to other positions within their respective elements away from sealing engagements with the surrounding surfaces of the aperture and closely proximate other respective attracting

magnets.

This valve assures a margin of safety against opening under conditions of overpressurization of the fluid supply. The pressure-enhanced seal prohibiting fluid flow, as previously described, and the limited magnetic force that is available internally to actuate the elements 25 and 34 establishes a maximum pressure above which the valve cannot be opened. This is particularly important if the valve is placed in a system upstream of a glass or quartz vessel (as is common in semiconductor manufacturing systems) which may rupture or be damaged by excessive fluid pressure. Thus, in contrast to conventional valves which may be forced open under manual control, or by sufficient air pressure or electromagnetic force applied to the valve, operation of this valve, in overpressure supply conditions remains immune to externally-applied forces that might be imprudently applied to force it open. Pushing down harder upon the button 49 does not apply more force to open the valve than can be provided by the magnetic attraction of magnets 29 and 39. The force available from these magnets can thus only overcome a certain limited supply of fluid pressure acting upon the effective area of the aperture. For a larger aperture and the same magnets 29 and 39, a lower level of supply pressure must be overcome to open the valve.

The seals 23 and 24 are modified to limit lateral shifting of the seals relative to modified sealing surfaces 21, 22. More particularly, each seal 23, 24 includes an outwardly facing spherical button or dome-shaped surface 54,56 respectively. These dome-shaped surfaces 54,56 are preferably received in modified sealing surfaces 21, 22. As shown, the sealing surfaces include frusto-conical recesses 58, 60 closely surrounding the aperture 19. Modification of the seals and sealing surfaces in this manner assures a tight sealing relationship therebetween and limits the effect of horizontal forces that may otherwise tend to dislodge the seal from its associated sealing surface.

Additionally, use of the valve in ultra-clean environments where contaminants must be closely controlled is enhanced by altering the construction of the movable element 25 and the sealing element 34. These elements 25, 34 are reduced in lateral dimension so as to result in the formation of an annular gap between the elements and sidewalls that greatly reduces the chance of minute particles resulting from friction between said elements and sidewalls, from contaminating the fluid.

To maintain the vertical and horizontal alignment of the movable element 25 a pair of opposed biasing means such as springs 70,72 are used. The first or upper spring 70 is interposed between the end plate 35 and the movable element 25. Preferably a portion of the spring 70 is welded into

the joint defined by the end plate 35 and valve body 9. Another portion of the spring is spot welded to the element 25. Similarly, the second or lower spring 72 is received on a radially extending shoulder 74 in the channel 15 and spot welded to the movable element 25 along the flange 37. The movable element is thus biased in floating relation in the channel. Contact between the element and end plate is prevented while tight engagement with the sealing surface 21 is maintained when the valve is in a closed position.

The sealing element 34 is, likewise biased at opposed upper and lower ends by springs 76, 78. The spring 76 is similar to spring 72 and spot welded to the element along a flange thereof and engages the radially extending wall 80 of the channel 17. The spring 78 is interposed between the end cap 36 and the face 82 of the sealing element 34. This arrangement also maintains the sealing element 34 in floating relationship within the channel 17 but does not interfere with the sealing contact between the dome-shaped surface 56 and the sealing surface 22.

Therefore, the fluid flow isolation and control apparatus according to the present invention tends to a normally closed setting, which apparatus is reliable and can be controlled externally by magnetic means without need for sliding seals or bellows between internal fluid channels and the environment. The integrity against back flow through the valve is preserved according to the present invention by providing double-acting sealing elements on both sides of an aperture, the lateral movement of which element is opposed when in a sealing location, which elements are under the unified control of a single source of magnetic flux. Also, the risk of contamination of any fluid within the valve, due to abrasive contact between any moving components of the valve, is reduced.

Claims

1. A valve comprising a valve body (9) having first (15) and second (17) channels contiguous with respective ports, of which one is a fluid inlet (11) and the other is a fluid outlet (13), a valve member (25) in said first channel (15) and having a seal face (54) co-operable with an aperture (19) between the first and second channels (15,17) for providing selective communication between said first (15) and second (17) channels, a first magnet (29) disposed in a chamber (27) defined in said valve member (25) and dimensioned relative to said chamber (27) such that it can move therein between first and second positions corresponding to open and closed positions of said valve member (25), a second magnet (32) disposed in said sec-

ond channel for magnetically urging said first magnet (29) to one of said first and second positions and magnet means (39) disposed remotely from said first and second channels for urging said first magnet to the other of said first and second positions, characterised in that said seal face has an outwardly extending domed surface (54) adapted for closing engagement with said aperture (19).

2. A valve as claimed in claim 1, further comprising a generally frusto-conical region adjacent said aperture for receiving said domed surface in the valve closed position.

3. A valve as claimed in claim 1 or 2, further comprising means for biasing said valve member into floating relation in said first channel.

4. A valve comprising a valve body (9) having first (15) and second (17) fluid channels, a valve member (25) disposed in said first channel (15) and having a seal face (54) co-operable with an aperture (19) between the first and second channels (15,17), a first magnet (29) disposed in a chamber (27) defined in said valve member (25) and dimensioned relative to said chamber such that it can move therein between first and second positions corresponding to open and closed positions of said valve member (25), a second magnet (32) disposed in said second channel (17) for magnetically urging said valve member (25) towards one of said open and closed positions and means (39) for magnetically attracting said valve member to the other of said open and closed positions characterised by means for biasing said valve member (25) into floating relation in said first channel (15) for limiting the contact with the surfaces thereof.

5. A valve as claimed in claim 4, wherein said valve member surface has a domed configuration selectively co-operating with a generally frusto-conical region adjacent said aperture;

6. A valve as claimed in any of claims 3 to 5, wherein said biasing means includes first and second springs operatively engaging opposed ends of said valve member.

7. A valve as claimed in any of the preceding claims and further comprising a second valve member disposed in said second channel having a seal face adapted for selective closing relation with said aperture, said second magnet being disposed in said second valve member.

8. A valve as claimed in claim 7, wherein said seal face of said second valve member has an outwardly extending domed surface.

9. A valve as claimed in claim 8, further comprising a generally frusto-conical region adjacent said aperture for receiving said domed surface of said second valve member in the valve closed position.

10. A valve as claimed in any of claims 7 to 9, further comprising second means for biasing said second valve member into floating relation in said second channel.

11. A valve as claimed in claim 10, wherein said second biasing means includes first and second springs operatively engaging opposed ends of said second valve member.

12. A valve as claimed in any of the preceding claims, further comprising a third magnet urging said second magnet away from the magnetic influence of said first magnet.

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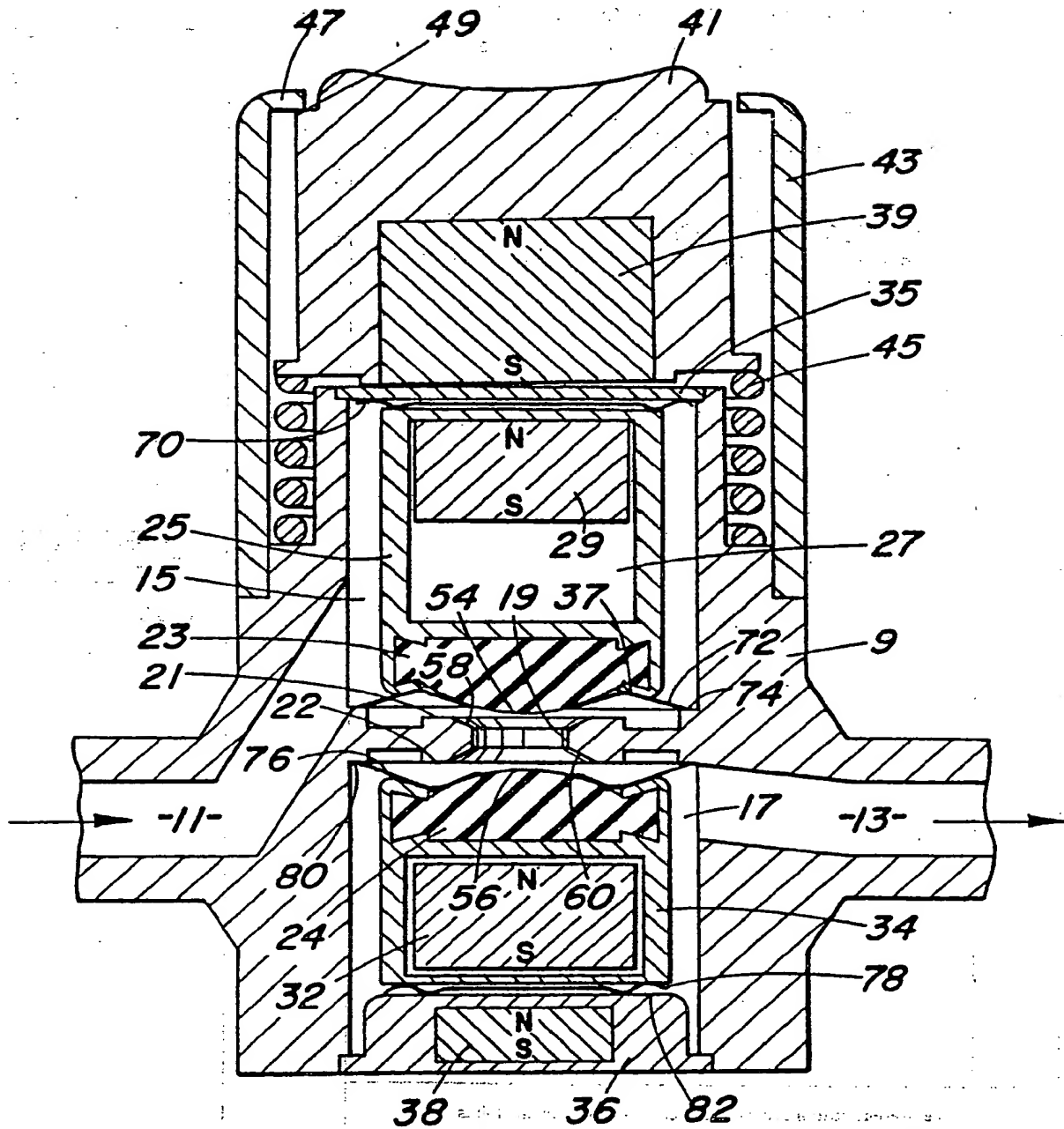
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European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 31 0817

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	GB-A-2 119 904 (F.R. PROSL et al.) * Page 3, line 2 - page 5, line 33 *	1,5.	F 16 K 31/08
A		3,4,6	
Y	GB-A-2 079 412 (GAST) * Page 1, lines 48-65 *	1,5	
A		2	
Y	DE-A-3 515 848 (BUCHHOLTZ) * Page 7, line 26 - page 12, line 31 *	1,5	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			F 16 K
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 11-03-1988	Examiner VERELST P.E.J.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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